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United States General Accounting Office

GAO

Report to the Chairman, Subcommittee on Transportation, Committee on Appropriations, House of Representatives

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March 1987

AVIATION ACQUISITION

Improved Process Needs to Be Followed

ORIGINAL

GAO/RCED-87-8

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

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March 26, 1987

The Honorable William Lehman
Chairman, Subcommittee on
Transportation
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

This report is in response to your June 23, 1983, request that we conduct continuing reviews of the Federal Aviation Administration's (FAA) National Airspace System (NAS) plan. This report, one of several that we have issued in response to that request, addresses FAA's management of the acquisition process used in implementing its plan.

We are sending copies of this report to the Secretary of Transportation; the Administrator, Federal Aviation Administration; and the Director, Office of Management and Budget. Copies are also being made available to other interested parties.

Sincerely yours,

J. Dexter Peach

J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

The Federal Aviation Administration (FAA) projects that 36,000 daily flights will transport nearly 2 million passengers by 1997. In 1985, nearly 25,000 daily flights carried an estimated 1 million passengers throughout the United States. In view of aging facilities and equipment, FAA has undertaken a major overhaul of its air traffic control system to meet this increased demand. Specifically, FAA plans to spend over $16 billion by the year 2000 to upgrade and modernize facilities and equipment to meet the projected increase in air traffic more effectively and economically. This technologically complex overhaul, known as the National Airspace System plan, is one of the largest civil procurement programs in the history of the federal government.

The Chairman, Subcommittee on Transportation, House Committee on Appropriations, asked GAO to initiate a continuing review of FAA's implementation of the plan. This report, one of several GAO has issued, focuses on FAA's management of the procurement process for major plan projects.

Background

In 1981, FAA initiated the National Airspace System plan to modernize the nation's air traffic control system, which is presently plagued by technically obsolete equipment. To successfully implement the plan, FAA must effectively manage over 150 individual projects involving hundreds of contracts, ensuring that they are on schedule and within estimated costs. The Department of Transportation, which has the final acquisition authority for the plan, has designated 11 of the 150 projects as major system projects on the basis of their cost and importance. These 11 projects will cost about $8 billion, or one-half of the total plan cost.

In 1976, the Office of Management and Budget (OMB) established its Circular A-109 as the principal process for acquiring major systems in the federal government. To avoid the problems previously experienced in acquiring major systems, Circular A-109 recommends decisionmaking at four critical stages of a major system's acquisition. The process attempts to avoid the premature commitment of a project to full-scale development and production by conducting periodic reviews of a project's cost, schedule, and performance. These reviews serve as the basis for the project's advancement in the process, leading ultimately to award of a contract for full production.

Results in Brief

FAA consistently moved projects into the last two stages of the acquisition process although they fell short of satisfying the approval criteria set forth in Circular A-109. None of the 11 major system projects were submitted for approval at either of the first two key decision points in the A-109 acquisition process. Projects were submitted with unreliable cost and schedule estimates, justifications required major revisions, and required project documentation was missing. FAA believed that these systems were sufficiently developed to be approved at one of the final two acquisition phases. Subsequently, however, all 11 systems experienced cost increases and/or schedule delays.

In the past year, FAA and the Department have made progress in incorporating A-109 principles and requirements into their acquisition process. These recent improvements will have only a limited effect on the 11 major systems because they are already in the final acquisition phases. Nevertheless, closer adherence to A-109 principles, including operational testing prior to making production decisions, could reduce incidences of cost increases and/or schedule delays in implementing the remainder of the NAS plan.

Principal Findings

FAA Did Not Follow A-109 Acquisition Process

Because of the cost and technological complexity of the major systems necessary for implementing the National Airspace System plan, those systems should be subjected to the periodic, detailed review process outlined by OMB Circular A-109. GAO found that throughout the plan's history, FAA had not closely followed the A-109 guidelines. Five of the 11 major systems projects advanced directly to the final production phase, and two others are awaiting a production decision. The remaining four major systems advanced directly to the phase just prior to production. FAA did not submit any of the 11 major systems for approval at either of the first two key decision points in the acquisition process outlined by A-109. FAA believed the systems represented off-the-shelf technology and were sufficiently developed to enter the acquisition process at these later phases.

However, the projects did not meet the A-109 approval criteria to advance to the next acquisition phase, and all 11 major systems have subsequently experienced cost increases and/or schedule delays. For instance:

- FAA requested the Department's approval to proceed into full production for the acquisition of the Terminal Radar project in February 1980 by submitting an acquisition paper. At that time, FAA estimated the cost of the project to be $154 million. According to the current Terminal Radar program manager, the system proposed by that acquisition paper would not have met FAA's needs. In a revised acquisition paper submitted in September 1981, FAA increased the cost estimate to $339 million, based on the addition of required subsystems.
- A project crucial to the success of the plan is the Advanced Automation System. According to FAA, the purpose of this system is to increase automation capability to handle the projected increase in flights and to enhance the productivity of the air traffic controller workforce. GAO, in a July 1986 report, questioned FAA's decision to award a production contract for this $3 billion system without first having operational test and evaluation data. FAA recently agreed to restructure the acquisition strategy for the system to provide some operational testing prior to production.

FAA Is Now Responding to Need to Conform to A-109 Principles

FAA has recently undertaken measures to correct deficiencies in its acquisition process. In addition to issuing its first Standard Operating Procedures to be followed in acquiring major systems, the agency has also established test and evaluation policies and procedures. FAA is also rethinking its approach to acquiring individual systems. In general, FAA's recent improvements will have limited effect on those systems that have already advanced to the final acquisition phases. Nevertheless, GAO believes that FAA and the Department have made significant progress in the past year by incorporating A-109 principles and requirements into their acquisition process.

Recommendations

GAO recommends that the FAA Administrator ensure that

- the major system projects not yet in the production phase be subjected to operational testing as recommended by OMB Circular A-109 and the resulting data be made available for the Department's production decisions and
- new projects be included in the improved acquisition process and receive the level of management review prescribed by OMB Circular A-109, and these projects be, in fact, sufficiently developed and documented to justify entering the acquisition process at the phase proposed.

Agency Comments

GAO furnished copies of its draft report to the Department of Transportation for its official review and comment, but the Department did not provide comments. However, GAO did meet with and discuss the draft report with Department and FAA officials, and their comments have been considered in the final version of the report. Basically, the FAA officials believed that the major system projects were sufficiently developed to enter the later acquisition phases. GAO's analysis of the 11 major system projects, however, shows that the projects did not meet Circular A-109 approval criteria for advancing in the acquisition process and that all have experienced cost increases and/or schedule delays.

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Abbreviations

AAS	Advanced Automation System
ASR	Airport Surveillance Radar
AWOS	Automated Weather Observing System
CWP	Central Weather Processor
DOT	Department of Transportation
FAA	Federal Aviation Administration
FSAS	Flight Service Automation System
GAO	General Accounting Office
KDP	key decision point
LRR	Long-Range Radar
MLS	Microwave Landing System
NAS	National Airspace System
OMB	Office of Management and Budget
RCE	Radio Control Equipment
RCED	Resources, Community, and Economic Development Division
R&D	research and development
RML	Radio Microwave Link
SEIC	systems engineering and integration contractor
SOPs	Standard Operating Procedures
TSARC	Transportation Systems Acquisition Review Council
VSCS	Voice Switching and Control System

Introduction

In 1985, an estimated 1 million passengers traveled on nearly 25,000 daily airline flights throughout the United States. The Federal Aviation Administration (FAA), which has the mission of safely controlling the nation's air traffic, predicts that by 1997, domestic air traffic will increase to nearly 2 million passengers aboard over 36,000 daily flights.

Because of aging facilities and equipment and the projected increase in air traffic, FAA embarked on a plan to modernize the nation's air traffic control system in December 1981. Known as the National Airspace System (NAS) plan, this ambitious effort represents one of the largest civil procurements in the history of the federal government.

Office of Management and Budget (OMB) Circular A-109 establishes the process by which executive agencies are to procure major systems, such as those included in the NAS plan. The process is intended to minimize the risks associated with procuring major systems and the potential for acquiring major systems which do not meet the government's needs. To achieve its intended purpose, Circular A-109 recommends a phased acquisition process, with reevaluations of the systems in terms of cost, schedule, and performance at four key decision points during the acquisition process.

Overview of the National Airspace System Plan

Faced with the projected increase in airspace system demand and the need to replace aging facilities and equipment that had evolved over 40 years, FAA issued its NAS plan to modernize and improve the nation's air traffic control system by the year 2000. The plan emphasizes higher levels of automation, the changeover from tube-type electronic equipment to solid-state devices, and the consolidation of facilities.

FAA did not have a firm cost estimate at the time it published the NAS plan but subsequently projected the cost at about $9 billion. FAA also estimated that implementation of the plan would result in savings in system operations and maintenance costs of $24.5 billion through the year 2000. These savings would be achieved primarily through enhanced productivity, a reduced work force, and consolidation of facilities.

The NAS plan is a major undertaking. It involves over 150 individual projects, 11 of which the Department of Transportation (DOT) has designated as major system projects because of their cost and importance. FAA must manage hundreds of contracts with over 1,000 "interfaces"

(where the implementation of one project directly affects the implementation of another) to ensure that the plan's projects come together at the right time and at the projected cost. For example, the critical Advanced Automation System interfaces with many other NAS plan projects, including the Host Computer project, the Mode S surveillance system, and the Voice Switching and Control System. Problems occurring in any of these related programs represent risks to the planned implementation of the Advanced Automation System.

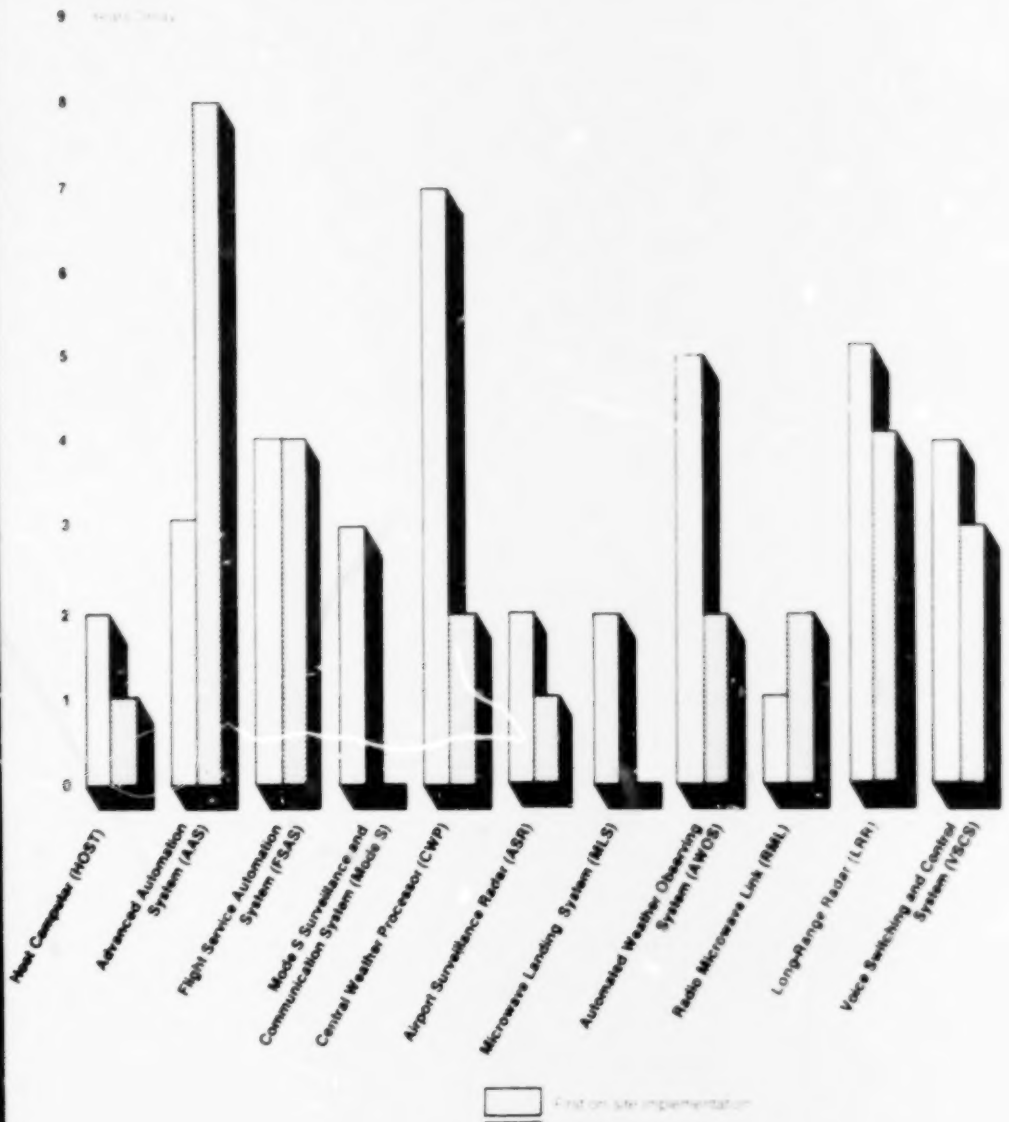
To assist the agency in managing the NAS plan, FAA hired a systems engineering and integration contractor (SEIC) in 1984 at a cost of $684 million. Subsequent modifications to the contract have increased the SEIC's responsibilities and the cost of the contract to $782 million. Additional cost increases totaling an estimated $100 million to $130 million are currently being negotiated.

One of the SEIC's first activities was to audit the NAS plan. In an August 1984 report, the SEIC stated that the plan could be implemented and would meet FAA's projected needs.[1] However, the SEIC also reported that for a number of reasons, including better project definition, increases in scope, and technical problems, 30 percent of the NAS plan project schedules had already slipped from 1 to 3 years since FAA first published the NAS plan. Because of these slippages, the SEIC found that the overall plan schedule was in jeopardy.

Figure 1.1 shows the number of years of delay currently projected for the first and the last on-site implementation for each of the 11 major NAS plan projects. For example, the May 1986 NAS Program Master Schedule Baseline indicates that the first and last on-site implementation for the Advanced Automation System (AAS) will be delayed 3 and 8 years, respectively, from the dates originally estimated in the December 1981 NAS plan.

[1] NAS Plan Audit Report (Martin Marietta Aerospace, Air Traffic Control Division, Aug. 1984).

Figure 1.1: Number of Years of Estimated Delays in Major NAS Plan Projects



Source: Comparison of December 1981 NAS plan and May 1986 NAS Program Master Schedule Baseline

The SEIC also reported that, while the estimated funding (which had been revised to $11.4 billion) appeared to be adequate, there was an equal chance of the cost either underrunning or overrunning the estimate. The SEIC reported that the NAS plan's cost could possibly increase from the lack of early program controls and firm baselines and the introduction of totally new system test and implementation approaches. Specifically, the SEIC noted

- the absence of well-defined project-level requirements and implementation plans,
- inadequately planned equipment quantities to meet requirements, and
- the lack of firm project milestones.

In its 1984 audit, the SEIC concluded that FAA had overstated the estimated NAS plan cost savings (projected at that time to be $19.9 billion) by approximately 10 percent. The SEIC's audit concluded that the 1984 NAS plan had underestimated the labor requirements to operate and maintain the NAS in the 1990 to 2000 period. The SEIC cautioned that further delays in facility consolidations, project schedule slips, and project start-up delays would continue to erode the plan's projected savings.

As currently defined by FAA, the NAS plan is an $11.7 billion, 11-year plan (fiscal years 1982-92). The $11.7 billion figure does not include project funds provided before 1982, research and development funds associated with the NAS plan projects, or project funding that will be required after 1992. With all of these excluded costs added to the $11.7 billion figure, the NAS plan will cost over $16.6 billion. Additionally, this $16.6 billion figure does not include an estimated $550 million for the Terminal Doppler Weather Radar project. This project will provide air traffic controllers with information concerning wind velocity and direction considered critical in identifying potential wind shears. FAA plans to include the Terminal Doppler project as part of the NAS plan at a later date.

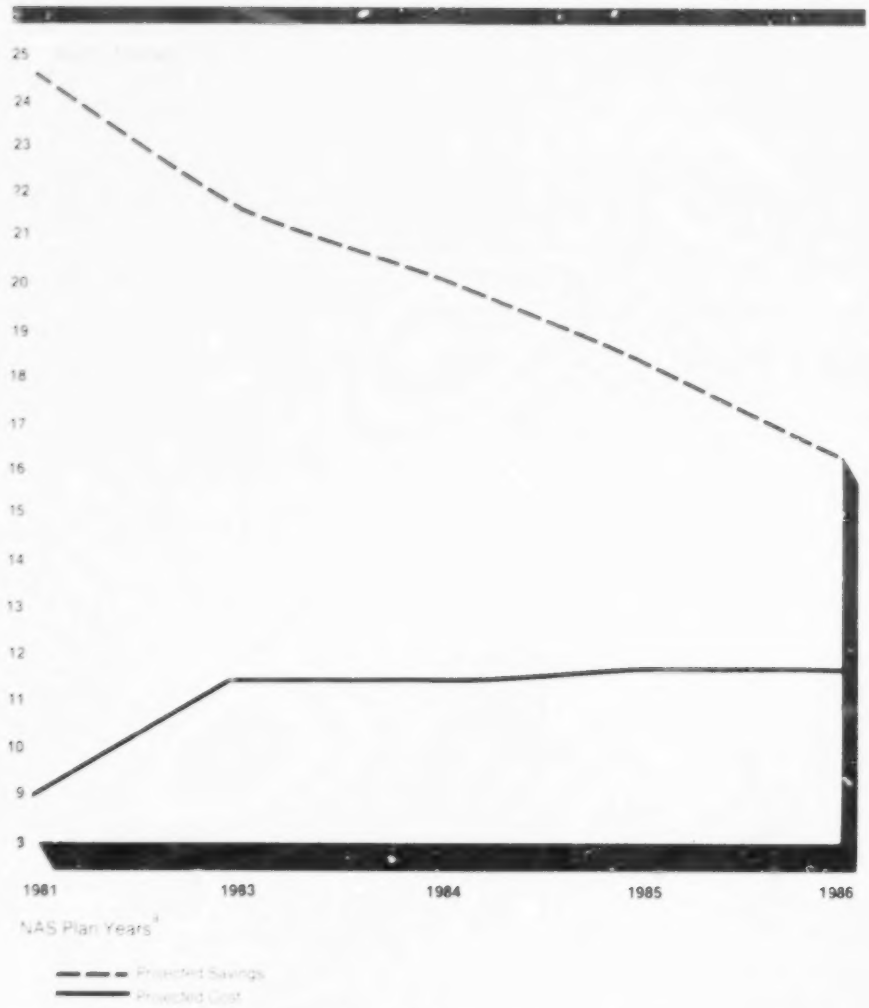
According to congressional hearings held in April 1986, FAA's estimate of NAS plan savings has steadily declined in successive NAS plan publications, from $24.5 billion in December 1981 to $21.5 billion in 1983, $19.9 billion in 1984, $18.3 billion in 1985, and $16.5 billion in 1986. FAA's Administrator attributes this downward trend to the following factors:

- Projections of air traffic activity, a major factor used in the calculation of NAS plan savings, is currently lower than originally forecast.

- FAA has refined its assessment of air traffic personnel productivity improvements for specific air traffic control projects, such as the Advanced Automation System, the Flight Service Automation System, Automated En-Route Air Traffic Control, and Area Control Facilities, and the net effect has been further reductions in projected savings.
- The SEI C's audit of the projected field maintenance personnel cost reductions concluded that only a "one-third reduction in technical staff" is achievable rather than the 50-percent reduction calculated in earlier plans.
- Estimated leased communications cost savings are lower than were initially calculated because of higher actual costs incurred as a result of industry deregulation.

Additionally, FAA's Administrator has repe tedly stated that, because of potential budgetary constraints, there is the possibility that the overall timetable for implementing the plan would slip, which could further increase costs and reduce potential savings. Figure 1.2 depicts the steady decline in expected savings and increases in projected costs of the NAS plan.

Figure 1.2: Trends in NAS Plan Projected Savings/Cost



Note: In its estimates of the cost to implement the NAS plan, FAA does not include project funding provided before 1982 or expected to be required after 1992, nor associated R&D funding. With these costs included, it is estimated that the NAS plan will cost over $16.6 billion.

aThe 1981 NAS plan was an 8-year plan covering fiscal years 1983 to 1990. The 1983 and 1984 NAS plans were 10-year plans covering fiscal years 1983 through 1992. The 1985 and 1986 NAS plans are 11-year plans covering 1982 through 1992.

Source: FAA

OMB Circular A-109

In 1976, OMB issued the policy for all executive agencies to follow in managing their acquisitions of major systems—OMB Circular A-109. The

circular is designed to minimize potential problems with the development and procurement of complex major systems by increasing top management's awareness of the technical, operational, and economic risks associated with the systems. The acquisition framework and policy established by A-109 is intended to reduce the potential for cost growth, schedule delays, and performance deficiencies, and avoid the premature commitment of major systems to production.

In accordance with OMB Circular A-109, agency heads are to reevaluate major projects at four critical points in the acquisition process in terms of cost, schedule, and performance, and reaffirm the need for the projects at each decision point. At each of the four key decision points, agency heads are to decide whether the projects are ready to move to the next phase in the acquisition process.

Acquisition Phases

The acquisition of major systems begins with the identification of a mission need. OMB considers that determining mission need is the most important part of the acquisition process. The thinking and planning involved in the phase affects the character, quality, and, ultimately, the cost of the major system which is procured.

Following the determination of mission needs, the A-109 acquisition process is divided into four progressive phases where passage from one phase to the next is decided by the agency head. The four acquisition phases are: (1) identification and exploration of alternative design concepts, (2) demonstration of alternative design concepts, (3) full-scale development and limited production, and (4) full production.

Identification and Exploration of Alternative Design Concepts

This initial phase of the A-109 acquisition process occurs when alternative system design concepts are solicited from a broad base of qualified firms. These firms submit their concepts to fulfill the identified mission need in a form suitable for preliminary evaluation. The intent is to generate innovation and competition for the best system design to meet the mission need.

Demonstration of Alternative Design Concepts

Once alternative system design concepts are selected, the project is advanced to the demonstration/test phase. Before awarding a contract for this phase, however, the agency must reaffirm its mission needs and project objectives. An agency head must decide whether to pursue alternative concepts or proceed with a single concept.

Full-Scale Development and Limited Production

Alternative system(s) can enter full-scale development, including limited production, only after the agency's mission need and program objectives have again been reaffirmed and demonstration results verify that the chosen system design concepts are sound. Agency head approval is again required for the project to move into full-scale development and limited production.

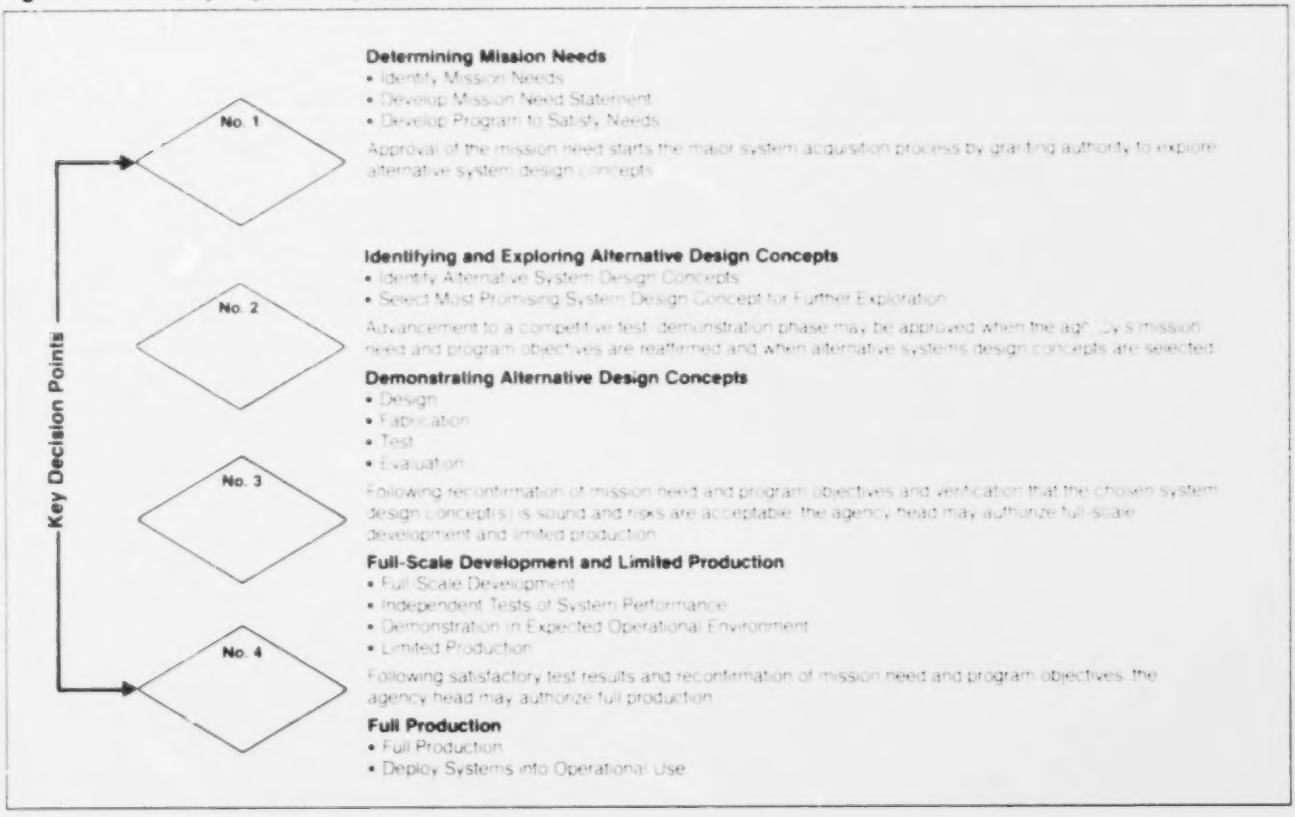
Full Production

Agency head approval is also required for a system to enter into full production. This decision is made only after reaffirming the agency's mission need and program objectives, and satisfactorily testing system performance under expected operational conditions. Operational testing is conducted independent of the agency's development and user organizations.

An important facet of OMB Circular A-109 guidance is that the production commitment should not be made until a system's performance is tested in a realistic operational environment. The importance of following this approach was recently affirmed in the February 1986 Interim Report of the President's Blue Ribbon Commission on Defense Management. That report concluded that full-scale development testing of weapons systems is critical to improve system performance and that systems should not go into high-rate production without operational test results.

The four key decision points and related activities at each decision point are shown in figure 1.3.

Figure 1.3: Basic Major System Acquisition Process


Key Decision Points
No. 1
No. 2
No. 3
No. 4
Determining Mission Needs
• Identify Mission Needs
• Develop Mission Need Statement
• Develop Program to Satisfy Needs
Approval of the mission need starts the major system acquisition process by granting authority to explore alternative system design concepts
Identifying and Exploring Alternative Design Concepts
• Identify Alternative System Design Concepts
• Select Most Promising System Design Concept for Further Exploration
Advancement to a competitive test demonstration phase may be approved when the agency's mission need and program objectives are reaffirmed and when alternative systems design concepts are selected
Demonstrating Alternative Design Concepts
• Design
• Fabrication
• Test
• Evaluation
Following reconfirmation of mission need and program objectives and verification that the chosen system design concept(s) is sound and risks are acceptable, the agency head may authorize full-scale development and limited production
Full-Scale Development and Limited Production
• Full-Scale Development
• Independent Tests of System Performance
• Demonstration in Expected Operational Environment
• Limited Production
Following satisfactory test results and reconfirmation of mission need and program objectives, the agency head may authorize full production
Full Production
• Full Production
• Deploy Systems into Operational Use

DOT's Implementation of OMB Circular A-109

Because FAA is an administration within DOT, the Department is ultimately responsible for approving the acquisition of major NAS plan projects. DOT has implemented OMB Circular A-109 acquisition policies through directives and memorandums which serve as the basis for the acquisition policies of its various administrations, including FAA. DOT's Order 4200.14B, dated January 6, 1983, Major Systems Acquisition Review and Approval, is the primary DOT directive implementing OMB Circular A-109. The directive designates the Deputy Secretary of Transportation as DOT's Acquisition Executive. As such, he is responsible for designating major projects and approving them at each key decision point in the acquisition process. The directive defines major systems as:

"... that combination of elements that will function together to produce the capabilities required to fulfill a mission need. . . . Major systems acquisition programs are

those programs that (1) are directed at, and are critical to, fulfilling a Departmental mission, (2) entail the allocation of relatively large resources, or (3) warrant special management attention. For the purpose of this Order, systems acquisitions which meet the requirements set forth above, or which have a total estimated acquisition cost of $150 million or more, or which have an anticipated total expenditure of $25 million or more in research and development funds shall be candidates for designation as a major system . . . ."

The Deputy Secretary fulfills his responsibility for approving the acquisition of major projects through his role as Chairman of DOT's Transportation Systems Acquisition Review Council (TSARC). Other TSARC members are the Assistant Secretaries of Transportation for Policy and International Affairs, Budget and Programs, Governmental Affairs, Administration, and Public Affairs, and the DOT General Counsel. The DOT order requires TSARC to review the acquisition of each major project at the four key decision points and, at other times, as directed by the Deputy Secretary. The reviews are to concentrate on the project's status in terms of its estimated cost, schedule, and performance requirements.

FAA's Implementation of OMB Circular A-109

FAA bases its major project acquisition process on OMB Circular A-109 and DOT Order 4200.14B. FAA Order 1810.1D, Major Systems Acquisition, dated July 13, 1985, establishes the current management policies and procedures for major project acquisitions. According to FAA officials, this directive substantially revised FAA's previous major project acquisition management process with the intent of improving the overall efficiency of the review process between FAA and DOT.

Previously, FAA had required only certain designated major projects to receive special management attention, based on their importance to the Agency. For example, the program manager was accountable directly to FAA's Administrator, independent cost and operational testing and evaluation reviews were required, and program reviews were required to be held more frequently than for nondesignated major projects. Also, FAA had an Aviation System Acquisition Review Committee (ASARC) to review each project before it was sent to TSARC.

FAA's current major project acquisition directive deleted the ASARC and its review function. Individual program managers now are accountable to the NAS Program Director who, in turn, is directly accountable to the FAA Administrator for all NAS plan activities. The new process also requires that FAA now subject all major projects to the same procedures.

Objectives, Scope, and Methodology

This report is one of a planned series of reports responding to a June 23, 1983, request by the Chairman, Subcommittee on Transportation, House Committee on Appropriations, that we continually monitor FAA's implementation of its NAS plan. Following that request, we initiated a series of reviews on individual NAS plan projects. These project reviews pointed out that FAA had not adequately identified the technical, operational, and economic risks associated with their implementation. Further, for many of these projects, FAA's acquisition strategy did not include a plan to minimize risks by adequately demonstrating a project's performance in an operational environment before committing it to full production.

Because of the problems noted in our reviews of individual NAS plan projects, and on the basis of discussions with Subcommittee staff, we agreed to provide the Subcommittee with an overview of FAA's management of the NAS plan major system acquisition process. Using information contained in our previous reports, as well as additional information developed during this review, we examined FAA's adherence to the fundamental principles of OMB Circular A-109, which established a phased acquisition process for major systems. Additionally,because of the significance of the NAS plan, we are planning to report in the future on the overall status of NAS plan systems and the causes of systems delays and cost increases.

Of the 11 NAS plan projects FAA currently defines as major systems, 5 projects were being reviewed by GAO and DOT's Office of Inspector General when we started this review in July 1985. We obtained and reviewed specific information relating to these five projects plus documentation for the remaining six.

From the six major systems not under review, we selected three to determine how well they adhered to the principles of OMB Circular A-109. At the suggestion of FAA officials, we included the Terminal Radar Program, which FAA believes is one of its "best managed" projects. The Terminal Radar Program, a $606 million major system, is currently in the production phase (the last phase) of the acquisition process. We selected the Voice Switching and Control System (VSCS) and the Radio Control Equipment (RCE) project as our other two projects. VSCS, a major project with a total estimated funding level of $429 million, is of critical importance to the operation of other NAS plan projects. DOT approved VSCS to begin full-scale development and limited production (the third of four phases) in February 1985. While the RCE project is not designated as a major project, its $203 million estimated cost exceeds DOT's $150

million threshold for consideration as a major project. (App. I contains a description of all major NAS plan projects.)

We compared the requirements of OMB Circular A-109, and DOT's and FAA's implementing orders and procedures, with FAA's acquisition process during implementation of the NAS plan. We examined FAA's major project acquisition process as a whole versus an examination of a single segment of the process.

Our analysis of how FAA submitted major NAS plan projects for approval is included in chapter 2. Chapter 3 contains a discussion of changes FAA has made, principally within the past year, to improve its acquisition process to more closely adhere to the A-109 process. Chapter 4 contains our conclusions and recommendations.

We performed our work at DOT and FAA headquarters, located in Washington, D.C. We interviewed DOT, FAA, and OMB officials and examined work from previous and current GAO reviews as well as reports by DOT's Office of Inspector General and other DOT and FAA reports.

Our review, conducted from July 1985 to December 1986, was performed in accordance with generally accepted government auditing standards. Copies of our draft report were furnished for DOT's review and comment, but the Department did not provide comments. We did, however, meet with and discuss the draft report with DOT and FAA officials, and their comments were considered in the final version of the report.

FAA Did Not Follow the A-109 Process

As a major acquisition effort, the NAS plan represents technical, operational, and economic risks. OMB Circular A-109 established policies for avoiding cost increases, schedule delays, and the potential acquisition of major systems which do not meet the government's needs, thereby reducing the risks associated with acquiring major systems.

Rather than subject the NAS plan major system projects to the sequential A-109 process, FAA submitted all the projects for DOT's acquisition approval at either of the final two phases of the acquisition process. FAA believed that the NAS plan major system projects were sufficiently developed to enter the acquisition process at the later stages. Our analysis of the 11 NAS plan major system projects shows, however, that the projects did not meet the A-109 approval criteria for advancing in the acquisition process and that all have experienced cost increases and/or schedule delays.

Major NAS Plan Systems Advanced Directly to Later Phases of OMB A-109 Acquisition Process

Circular A-109 establishes a phased process for acquiring major systems. At each of the four key decision points in the acquisition process, agencies are to reconfirm the mission need which the system is to meet and reevaluate the system's estimated cost, schedule, and performance specifications. On the basis of this reevaluation, agencies must then decide if the system meets the A-109 criteria for advancing to the next acquisition phase.

FAA, however, submitted all the NAS plan major system projects for acquisition approval at either of the last two phases of the acquisition process. FAA believed that the projects represented off-the-shelf technology or had been in existence before A-109's issuance and, therefore, were sufficiently developed to be ready for the final two acquisition phases.

As shown in table 2.1, FAA submitted 4 of the 11 systems for DOT's review and approval to advance directly to the third phase of the acquisition process (i.e., full-scale development and limited production). Of the remaining seven systems, FAA submitted six to advance directly to the fourth and final phase of the acquisition process (i.e., full production) and expects to submit the seventh directly for production approval in the near future.

Table 2.1: Summary of NAS Plan Major System Approvals

Project	Estimated Cost (millions)	DOT Approval of Key Decision Points KDP#1	KDP#2	KDP#3	KDP#4
Flight Service Automation System (FSAS)	$480.1				Aug. 1981
Airport Surveillance Radar (ASR)	606.2				May 1982
Mode S Surveillance and Communication System	526.0				Mar. 1983
Host Computer Project	405.8			Mar. 1983	June 1985
Microwave Landing System (MLS)	1,494.4				Apr. 1983
Advanced Automation System (AAS)	3,187.2			Apr. 1983	
Radio Microwave Link (RML)	264.3				Mar. 1984
Central Weather Processor (CWP)	154.9			Jan. 1985	
Voice Switching and Control System (VSCS)	428.6			Feb. 1985	
Automated Weather Observing System (AWOS)	203.1				Submitted not yet approved
Long Range Radar (LRR)	485.2				Not yet submitted for approval
Total	$8,235.8[a]				

[a]The cost of these 11 major systems amounts to one half of the total NAS plan cost of $16.62 billion.

For at least two of the major systems we have reviewed, FAA elected to use an accelerated acquisition strategy, bypassing key decision points 1 and 2 in favor of a "concurrent" acquisition approach. Using this approach, FAA conducts full-scale system development and testing parallel with system production. We have questioned the reasonableness of this approach and have recommended that FAA change this practice.[1]

FAA's Accelerated Acquisition Strategy Not Justified

Two of the most costly and critical NAS plan projects are the Host computer project and the Advanced Automation System (AAS). According to FAA, these systems will provide needed computer capability to meet the projected increase in air traffic. FAA estimates that the Host project will cost over $400 million and AAS over $3 billion.

We have questioned FAA's justification for the accelerated acquisition of the Host computer project without complete and realistic operational

[1]FAA's Advanced Automation System Acquisition Strategy Is Risky (GAO/IMTEC-86-24, July 8, 1986).

testing.[2] In June 1985, we reported that the model used to justify this strategy contained unverified assumptions that did not provide the precision and confidence necessary to make future workload projections. We, therefore, stated that the use of these unverified assumptions called into question whether FAA's accelerated procurement of the computer was justified.

In a follow-up report issued in July 1986,[3] we noted that FAA awarded a production contract for the Host project in July 1985, with the first system delivery scheduled for May 1986. FAA subsequently revised that delivery schedule, delaying delivery by 6 months because of contractor problems in modifying the existing air traffic control software and in developing acceptable system documentation.

In our July 8, 1986, report on the AAS project, we noted that FAA's acquisition strategy for the AAS combined development, testing, and production into one phase. Although A-109 recommends operational testing to determine actual system performance before a commitment is made to full production, FAA would not have performed operational testing prior to the AAS production decision. FAA believed that to do so would unnecessarily delay project implementation and increase its cost. Instead, FAA intended to make the production decision on the basis of the contractor's paper designs, computer-model simulations of system performance, and design trade-off analyses. Our report stated that this strategy had unacceptably high risks and could have resulted in significant cost increases, schedule delays, and performance deficiencies.

FAA believed its acquisition strategy was sound because (1) the planned fixed-price type contract indicated that the contractor believed the risks were acceptable and (2) the noncompetitive environment would enable close FAA-contractor interaction.

We disagreed with these explanations. A fixed-price for untested hardware may result in higher costs because the contractor's risk may be reflected in higher fixed prices to compensate for the system's unproven producibility. Additionally, requirement changes to correct performance problems can lead to significant additional costs even in a fixed-price contract. Finally, the software for the system—which constitutes a

[2]Federal Aviation Administration's Host Computer: More Realistic Performance Tests Needed Before Production Begins (GAO/IMTEC-85-10, June 6, 1985).

[3]Status of FAA's Host Computer Project and Related Software Enhancements (GAO/IMTEC-86-25BR, July 3, 1986).

major portion of the AAS development risk—will be developed using a cost-plus type contract. With regards to FAA's second point (noncompetitive environment), having only one contractor during the concurrent development, testing, and production phase limits the risk-reduction opportunities typically achieved through cost and technical competition.

Following issuance of our July 1986 report, DOT and FAA agreed that the AAS acquisition strategy needed to be modified to reduce the management and technical risks associated with the program. As a result, FAA recently submitted to DOT a plan to restructure the AAS program. We are currently analyzing that plan, which does provide for some operational testing prior to production, to assess the extent to which the revised strategy addresses concerns expressed by us and the Congress with the AAS program.

Systems Submitted for Approval Did Not Meet A-109 Criteria

To manage the acquisition of major systems, FAA should ensure that projects meet the applicable A-109 criteria and are, therefore, ready to advance to the next acquisition phase. If FAA makes the decision to advance a project when it is not ready, the potential exists for schedule delays, cost increases, and ultimately producing a system which does not meet FAA's operational requirements, the circumstances A-109 was designed to avoid.

For the projects reviewed, we found that FAA had frequently submitted them to DOT for approval to advance in the acquisition process with unreliable project cost, schedule, and performance estimates. Additionally, FAA submitted projects without the required documentation, causing delays and project changes. Our analysis of the NAS plan major system projects shows that all of the projects have experienced delays and/or cost increases. (See app. II.)

The Terminal Radar Project

The Terminal Radar project provides the airport surveillance radars which air traffic controllers use to monitor the airspace above and around airports. Controllers use data obtained from these systems to control and separate aircraft, thus expediting the safe flow of traffic in the terminal environment.

DOT designated the project as a major system in November 1978. In February 1980, FAA began the A-109 process by submitting an acquisition paper, showing an estimated project cost of $154 million, for DOT's review and approval to proceed into full production, the last step in the

acquisition process (key decision point 4). According to project officials, they believed the project was ready to advance directly to full production because (1) most of the individual components of the system had already been developed and tested, (2) the technical risk associated with integrating the subsystems into a complete system was considered minimal, and (3) the production contractor would submit the first production system for a system test to ensure compliance with the specifications. Circular A-109, however, requires that agencies test and evaluate a project (and the individual subsystems comprising a project) and ensure that it fully meets operational requirements before requesting full production approval.

In July 1980, FAA told DOT that a major restructuring of the terminal radar program was necessary and withdrew its acquisition paper from DOT's consideration. In September 1981, FAA submitted a revised acquisition paper showing an estimated cost of $339 million for the project. The paper attributed the $185 million increase in the estimated project cost between the original proposal and the revised proposal to the inclusion of costs for major subsystem components and updated cost information. According to the current program manager, if these major subsystem components had not been added, the system would not have met FAA's operational requirements.

DOT acquisition approval for FAA's Terminal Radar project was delayed for more than 2 years also because FAA did not demonstrate that the project met A-109 criteria. DOT representatives opposed FAA's moving directly into full production because (1) FAA had not demonstrated actual hardware in the expected operational environment, (2) FAA was still testing a major subsystem of this project, (3) the overall system design did not exist, and (4) FAA had not provided required documentation, including the economic analysis and the charter defining the role and responsibilities of the program manager.

Compared with its original schedule, the schedule for implementing the first system has slipped by 2 years to 1987. The program manager stated that the first dates were only estimates and that firm dates were developed after program implementation and award of contract in 1983. FAA has also revised the estimated cost of the project from $154 million to over $606 million. Factors which have contributed to this cost growth are the (1) inclusion of costs for certain major components omitted from the initial estimate, (2) costs for additional features, requirements, and technical changes, and (3) addition to the program in 1982 of costs for relocating existing radar systems to other airports.

The Voice Switching and Control System

The Voice Switching and Control System (VSCS) provides the man-to-machine communications link in the air traffic control system. VSCS also provides the switching control system for voice communications.

DOT designated VSCS a major system project in June 1982. In September 1984, FAA submitted project documentation for acquisition approval at key decision point 3, the full-scale development and limited production phase. To begin the formal project review and acquisition process at this point, A-109 requires that agencies reevaluate and reconfirm the project's cost estimate as accurate and current. In November 1984, DOT deferred approval of the project, pending FAA's completion of the project's specifications.

In February 1985, FAA resubmitted the project documentation for approval with a revised cost estimate. FAA explained that the revised cost estimate for the two prototype development contracts had decreased from $87 million to $69.1 million as the result of using a different cost-estimating factor. FAA pointed out that the original cost estimate was based on a 80/20 confidence factor (i.e., 80 percent confidence that the estimate would not be exceeded) while the revised estimate was based on only a 50/50 factor, consistent with cost estimates for the other NAS plan programs.

Confusion over FAA's cost-estimating procedures prompted DOT's Deputy Secretary to establish a task force to evaluate FAA's procedures in estimating the costs of the other NAS plan major projects. The task force's August 1985 draft report stated that procedures were in place but did not verify FAA's compliance with them. According to an official in the Office of the Secretary of Transportation, DOT does not plan to verify FAA's compliance with these procedures.

FAA has revised its original estimate for first-unit production in 1986 to the current estimated implementation in 1990. According to program management officials, the delay is due primarily to FAA's major revision of the project's operational requirements. As a result of the revised operational requirements and a doubling of the number of units originally planned, FAA has revised the cost of the project from $258 million to $429 million.

Radio Control Equipment

The Radio Control Equipment (RCE) system is another project which has experienced delays in the acquisition process. Although not designated a major system, RCE is, nevertheless, important to the success of the NAS

plan because it replaces existing air-to-ground communications equipment.

When DOT approved the project for production in 1983, FAA estimated the cost at $180 million. FAA now estimates the system will cost $203 million. Cost increases have resulted, in part, from subsequent add-ons to the RCE system and schedule delays. FAA has revised the project's scheduled implementation from 1985 to 1989.

Potential for Acquiring Systems That Do Not Meet FAA's Needs

The A-109 acquisition process was designed to direct special management attention to major acquisitions to preclude the government's acquisition of costly systems which do not meet agency needs. However, none of the 11 major NAS plan projects were subjected to the entire A-109 process. In addition, 6 of the 11 projects are already in the production phase of the acquisition process, and FAA has scheduled two other projects to go directly to production. At least two of the projects have experienced problems in meeting their operational requirements and thereby fulfilling FAA's mission.

In a July 1985 report, we stated that FAA's operational testing showed that the Automated Weather Observing System (AWOS) did not meet operational requirements for four of the nine weather elements considered essential to providing airport and area aviation weather forecasts.[4] FAA considers these forecasts essential to maintaining aviation safety. Conversely, existing weather observations at these airports made by observers using equipment to measure or estimate the nine weather elements not only met or exceeded the operational requirements but were also more cost-effective. We, therefore, recommended that DOT not request funds for installing AWOSs at commercial airports until the system met these requirements and was more cost-effective than the existing weather observing system. DOT agreed with our recommendation.

We have also found that the Microwave Landing System (MLS) project is experiencing technical problems that have delayed the installation of the first system by about 2 years. In February 1983, FAA submitted the project for production approval, bypassing the first three key decision points. DOT approved the project for production in April 1983, and FAA subsequently awarded a production contract in January 1984. In March

[4]Installation of Automated Weather Observing Systems by FAA at Commercial Airports Is Not Justified (GAO/RCED-85-78, July 29, 1985).

1986, the primary contractor advised FAA that it had been unable to develop the necessary software and it would, therefore, have to subcontract for software development. As a result, FAA now plans to use revised MLS performance specifications for the second round of procurements and has rescheduled delivery of the first unit from mid-1985 to July 1987.

Actions Have Been Taken to Improve the Acquisition Process

DOT and FAA have recognized problems in the acquisition process and have taken a number of steps which they believe will refine and improve that process. Both have periodically revised their acquisition directives to incorporate improved policies and procedures and to conform them with A-109 requirements and principles. In addition, FAA has taken actions to improve its internal management controls over the acquisition process. The most significant actions have been the establishment of policies and procedures for testing and evaluating projects, and the development of standard procedures for originating, coordinating, reviewing, and approving project documentation. Other actions taken to improve FAA's internal management controls over the acquisition process are described in appendix III. They include

- the establishment of policies and procedures for developing independent project cost estimates,
- the creation of a staff to provide management support to the NAS Program Director,
- the development of a baseline process to track the progress of NAS plan projects,
- the acquisition of the services of a systems engineering and integration contractor to provide FAA with management and technical support during implementation of the plan, and
- increased cross-organizational involvement in project development and review.

We support these management actions and believe that management attention to their implementation will result in an improved acquisition process. Most of the actions cited, however, have taken place relatively recently, principally within the past year. Therefore, while these improvements in the acquisition process are encouraging for future projects, they will have only a limited effect on current NAS plan projects since most of the major projects which are currently part of the NAS plan have already progressed into the production phase of the acquisition process. In addition, even though these improvements recognize a four-phased acquisition process, FAA continues to submit projects at the last two acquisition phases, bypassing the initial two phases.

Issuance of Directives in Response to Circular A-109

Over the years, DOT and FAA have implemented acquisition policies and procedures through the issuance and periodic revision of directives. Following the issuance of Circular A-109 in April 1976, both DOT and FAA issued directives to implement the requirements and intent of A-109. In addition to defining and expanding the policy guidance contained in

A-109, these directives described how the major system acquisition process is to function throughout DOT and FAA.

DOT Directives

In January 1977, DOT issued a directive in response to A-109. The directive described the planned procedures for implementing A-109 and provided temporary acquisition guidance to DOT's operating elements.

In May 1978, DOT finalized and published its initial policies and procedures for implementing A-109. The directive designated the Deputy Secretary as DOT's Acquisition Executive and made him responsible for determining the projects to be subjected to A-109 and for approving those projects at each of the key decision points in the acquisition process.

In January 1983, DOT issued its current directive, DOT 4200.14B. This directive addressed oversights and weaknesses in the earlier directive by adding, revising, and clarifying key provisions, and conforming DOT's acquisition policies and procedures with the requirements and intent of A-109. Some of the more significant provisions DOT included in its 1983 directive were

- new and updated references to relevant DOT orders and OMB releases, including the OMB policy paper of August 1976, which provided a detailed discussion of the intent and application of A-109;
- clarified instructions for developing acquisition cost estimates;
- revised explanations of the four key decision points established by A-109;
- an expanded discussion of the role of program managers and an outline of the basic elements to be addressed in program manager charters;
- additional instructions on the development and content of acquisition papers; and
- a revised discussion of the requirements for project monitoring and reporting.

FAA Directives

In March 1977, FAA issued its initial acquisition directive in response to A-109, and subsequently revised it in March 1978. These directives, although citing both DOT's acquisition directive and A-109, did not conform with some of the key provisions contained in those directives. For example, the FAA directives called for only two key decision points in the acquisition process—a development phase and an implementation phase—as opposed to the four cited by the DOT directive and A-109.

FAA issued a revised directive in November 1980. This directive discussed the four key decision points in the acquisition process and established the Aviation System Acquisition Review Committee (ASARC) within FAA to provide high-level management oversight of FAA's acquisition process.

In August 1982, FAA again revised its acquisition directive. This directive, together with changes in February 1983 and November 1984, substantially revised and clarified FAA's acquisition process and conformed FAA's acquisition policies and procedures closer with DOT's directive and A-109. Some of the more significant changes included (1) increased authority and accountability for program managers, (2) the introduction of program directives to record understandings between program managers and line organizations as to the work to be performed and the resources to be provided, (3) revised formats for critical project documents, and (4) requirements for both cost and operational testing and evaluation staffs.

In July 1985, FAA issued its current directive, FAA Order 1810.1D. This directive incorporated revised FAA policies and procedures for managing the major system acquisition process and further clarified the requirements and principles of OMB Circular A-109. Among the changes FAA included in this order were

- the recognition of the new position of NAS Program Director and the System Acquisition Management Programs Review and Evaluation Staff;
- the establishment of "cluster management," whereby designated managers are responsible for the management of related groups of NAS projects; and
- the clarification of the content of the critical acquisition documents required by decisionmakers.

We support FAA's actions to conform its acquisition directive with the requirements and principles of A-109. However, FAA submitted all of the NAS plan major system projects directly to the later phases of the acquisition process, and DOT approved them before FAA instituted many of the recent improvements in its acquisition process. According to FAA, over 52 percent of the NAS plan projects involving major acquisitions were under contract as of September 30, 1984. Moreover, FAA had committed over 65 percent of the moneys required for funding these acquisitions by that time. By September 30, 1985, FAA had nearly 70 percent of the

projects under contract and 79 percent of the required moneys committed.

Establishment of Test and Evaluation Policies and Procedures

FAA's major system acquisition directive of August 1982 established a requirement that the Operational Test and Evaluation Staff prepare an independent evaluation of the adequacy of tests made on both hardware and software acquisitions. This evaluation was intended to ensure that the project requirements specified in the System Requirements Statement are met. Certification that the acquisition meets the project requirements was to be made prior to the production decision, i.e., key decision point 4. It was not until FAA issued its order Independent Operational Test and Evaluation for Major Systems Acquisitions in June 1983, however, that FAA established the detailed policy, requirements, and responsibilities for the required independent operational testing and evaluation.

In addition, not until recently did FAA have a directive specifying its policy for testing the NAS plan projects. In August 1984, FAA formed a working group to develop a policy addressing all aspects of testing and evaluation for the NAS plan projects. The goal was to develop a policy identifying testing requirements and responsibilities for the entire development and acquisition process, with particular emphasis on the predeployment phase.

FAA published an interim policy for testing the NAS plan projects in December 1985. By that time, however, at least 44 (64 percent) of the 69 NAS plan projects identified as requiring testing were categorized by the working group as projects which had already progressed past the point where a new test policy could be practically applied to them.

As previously discussed in chapter 2, FAA is not fully implementing its written policies and procedures regarding operational testing and evaluation. FAA plans to continue making production decisions for major systems before complete operational test and evaluation results are available.

Publication of Standard Operating Procedures

In a study of FAA's acquisition process issued in December 1984,[1] an FAA review team repeatedly noted that the quality of project documentation and supporting data being developed within FAA constituted a problem. The team further pointed out that much of the problem could be traced to a lack of written operating procedures concerning the origination, coordination, review, and approval of key project documents. As a result, the review team recommended that FAA prepare written operating procedures to guide program sponsors, program managers, and others involved in the FAA acquisition process.

In response to that recommendation, FAA issued its System Acquisition Standard Operating Procedures (SOPs) in June 1985. The SOPs provide specific, detailed guidance for the preparation, coordination, and approval of the project documents key to the acquisition process. According to FAA management officials, the SOPs which have been issued have proved to be a valuable tool, not only to those responsible for preparing critical project documents, but also to those charged with coordinating, reviewing, and approving the documents. FAA officials point out that the data submissions and reviews are now better and more timely.

[1] Report to the Administrator on a Review of the FAA Acquisition Process, December 12, 1984. (Review team made up of a long-time FAA official responsible for program evaluation, an executive of the SEIC with extensive management experience in major systems acquisitions with DOD, and a former FAA official with previous responsibility for managing the airways improvement facilities and equipment program.)

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Conclusions and Recommendations

The Circular A-109 sequential approval process for acquiring major systems was designed to avoid cost increases, schedule delays, and the potential acquisition of major systems which do not meet the government's needs. Because it believed that the NAS plan major system projects were sufficiently developed, FAA submitted them to DOT for acquisition approval at either of the last two phases of the A-109 process.

However, for those projects we reviewed, we found that FAA had submitted them before they fully met the A-109 criteria for advancing to the next acquisition phase, resulting in cost increases and/or schedule delays for all 11 NAS plan major systems. We also found that cost and schedule estimates were unreliable, justifications required major revisions, and required project documentation was missing or inadequate. In addition, at least two of the projects have experienced problems in meeting FAA's operational requirements. The types of problems FAA experienced in acquiring the NAS plan major system projects are the types the A-109 process sought to avoid.

DOT and FAA have recognized weaknesses in FAA's major system acquisition process and have taken steps to improve that process. They have revised their acquisition directives to incorporate improved management policies and procedures and to conform them with the requirements and principles of OMB Circular A-109. In addition, FAA has taken a number of actions to create better internal management controls over the total acquisition process.

The actions taken should improve FAA's major system acquisition process. However, most of these improvements have occurred recently, principally in the past year.

While improvements to FAA's major acquisition process have been made too late to be of benefit to most of the 11 major NAS plan projects, some of the projects, including the critical AAS project, can still benefit from these improvements. In addition, other projects are expected to be designated major projects in the future and these projects should benefit from the improvements FAA has made.

Recommendations

We recommend that the FAA Administrator ensure that

- the major system projects not yet in the production phase be subjected to operational testing as recommended by OMB Circular A-109 and the

resulting data be made available for the Department's production decisions and

- new projects be included in the improved acquisition process and receive the level of management review prescribed by OMB Circular A-109, and that these projects be, in fact, sufficiently developed and documented to justify entering the acquisition process at the phase proposed.

Major NAS Plan Projects

The following is a general description and status of each of the 11 major NAS plan projects. The information is, for the most part, taken from the current NAS plan project resumes and from project descriptions contained in the SEIC's August 1984 evaluation of the NAS plan.

Advanced Automation System (AAS)

Because the current en-route and terminal automation systems were approaching the end of their useful lives and could not accommodate FAA's planned consolidation of terminal and en-route operations into a single system at the planned Area Control Facilities, FAA decided that a totally new automation system design was required.

According to FAA, AAS will provide the primary upgrade to air traffic control automation capability in the NAS plan. It will provide the foundation for the Automated En-Route Air Traffic Control system and is the key system through which the benefits for the Next Generation Weather Radar, the Mode S surveillance and communication system, and the Central Weather Processor will be realized. AAS will contribute to the NAS plan's operational, cost, and expandability goals. Operationally, the system will improve air traffic control efficiency and safety and provide for increased NAS capacity. AAS is also expected to contribute to decreasing NAS maintenance costs by providing highly reliable hardware and software and reducing the maintenance staff needed. The system will provide the computer capacity needed to support facility consolidation—a major cost benefit in the NAS plan. Finally, AAS is structured to be expandable to meet future growth requirements. This expandability is targeted both to software and hardware.

Status

DOT approved the project for full-scale development and initial production in April 1983, and two design contracts were awarded in August 1984. DOT authorized a 6-month extension to the contracts in October 1985 at an additional cost of $128.3 million. FAA is currently discussing restructuring the AAS project to address congressional concerns over the risks in proceeding to full production without adequate testing. Total funding required for the program is estimated to be about $3.2 billion.

Automated Weather Observing System (AWOS)

AWOS is designed to automatically collect weather observation data and distribute the data to pilots, FAA weather observers, and National Weather Service aviation weather forecasters. According to FAA, AWOS will increase efficiency at commercial airports by reducing the amount of time now required to make weather observations and by reducing or

eliminating the higher maintenance costs of obsolete weather-observing equipment currently in use. Consequently, FAA plans to install 304 AWOSs at commercial airports and 441 AWOSs at general aviation airports (those serving private aircraft only) where no weather observations are currently provided. FAA expects that such systems, by providing weather data where none are now available, will reduce the number of private aircraft accidents, thereby enhancing flight safety.

Status

The project's schedule has been delayed as a result of the unreliable technical performance of sensors and a change in the procurement strategy. DOT has not yet approved this program for any key decision point. The AWOS program is estimated to cost about $203 million.

Central Weather Processor (CWP)

CWP is planned to provide needed improvements in the quality of weather information available throughout the NAS by automating many of the weather-data processing and disseminating functions, including the distribution of near real-time weather information to controllers. A total of 26 production systems are planned and are to be implemented by the end of 1993.

Status

DOT approved this program to proceed with full-scale development and initial production in January 1985. Prototype delivery to the FAA Technical Center for test and evaluation is scheduled for March 1989. The estimated cost of this program is about $155 million.

Flight Service Automation System (FSAS)

To meet an increased demand for services, FAA plans to automate flight service stations, enabling pilots to brief themselves either through a computer terminal or by use of a "touch-tone" telephone.

FSAS will be implemented in three segments, called models 1, 2, and 2 enhancements. With model 1, FAA's objective is to quickly establish a limited-capability automated system at its 37 busiest stations. Model 2 will automate all the manual operations now carried out by specialists and will have the capacity to handle the workload of 318 stations. Model 2 enhancements will incorporate additions and improvements to model 2, enabling pilot self-briefings. In this way, the present and projected long-term demand for preflight services can be met without a proportional increase in staff or operating costs.

Status

DOT approved the program to proceed with full production in August 1981. The first Model 1 system was commissioned in February 1986. The estimated cost of the program is about $480 million.

Host Computer

The current en-route and terminal computers in use in the NAS are of 1960's vintage and are approaching obsolescence. The total hardware/software replacement of these systems with a common system will not be completed until the early 1990's. To provide the computer capacity for the demand projected for the late 1980's, the en-route computers must be replaced prior to full AAS implementation. This replacement will take the form of computers called Host, which will use existing software with minimum modification.

The purpose of the air traffic control Host computer is to provide needed computer capacity for the present en-route system as early as is practical. The modernization consists of implementation of the Host computers, which is the first step of the advanced automation program, and will provide the required capacity until the AAS has been fully implemented.

Status

DOT approved this program to proceed with full-scale development and initial production in March 1983 and full production in June 1985. The first Host computer went to the FAA Technical Center in August 1985. FAA expects to have the computer systems operational at all 20 Air Route Traffic Control Centers by the end of 1987. The estimated cost of this program is about $406 million.

Long-Range Radar (LRR)

The NAS plan requires the networking and upgrading of en-route radar and terminal radar into a cost-effective system providing primary radar coverage of both en-route and terminal airspace. The present LRR system has surpassed its design life expectancy.

This program is for the procurement and installation of 48 3-dimensional radars (range, azimuth, height) to be located at 39 existing joint-use, long-range radar facilities; 8 existing military-only sites; and the FAA Academy. The FAA and U.S. Air Force determined that, owing to the age of the present equipment and anticipated poor logistics supportability, replacement of joint-use, long-range radars and height-finder radars is required. They also determined that a combined

3-dimensional radar would be the most cost-effective method for providing a suitable replacement.

Status

Although this project was scheduled for key decision point 4 approval in July 1986, it had not yet been submitted for DOT's consideration as of September 1986. (FAA had not submitted this project for prior key decision point approval). The estimated cost of the program is about $485 million.

Microwave Landing System (MLS)

The MLS program was initiated in 1971. In 1979, the Service Test and Evaluation Program was initiated to gain initial operational experience with MLS and to develop operational procedures and criteria. A transition plan was published in 1981 which defined the strategy for MLS implementation.

The project's objective is to develop and implement a new common civil/military approach and landing system that will meet the full range of user operational requirements well into the future and be selected for international standardization as the replacement for the current Instrument Landing System.

Status

DOT approved this program to proceed with full production in April 1983. A contract for the first purchase of 208 MLS systems was awarded in January 1984. Contractor delays, attributed to software and personnel problems, are expected to slow production by about 1-1/2 years. The estimated cost for the MLS program is about $1.5 billion.

Mode S

Mode S is a cooperative surveillance and communication system to support air traffic control and provide other data link services. It employs ground-based sensors and airborne transponders. Ground-to-air and air-to-ground data link communications are integral with the surveillance interrogations and replies. In Mode S, each aircraft is assigned a unique address code. Using this unique code, interrogations can be directed to a particular aircraft and replies can be unambiguously identified. Interference is minimized because a sensor limits its Mode S interrogations to specific targets, and proper timing of interrogations permits replies from closely spaced aircraft to be received without mutual interference.

The objective of the Mode S program is to provide the improved surveillance and communications capabilities required to meet the need of automated air traffic control in the 1980's. Specific goals are

- overcoming surveillance limitations of the present air traffic control radar beacon system,
- providing an integral two-way data link,
- evolutionary transition from the present system,
- reasonable cost to the airborne user, and
- high availability and reliability.

A total procurement of 197 Mode S systems is planned. The first procurement of 137 systems will provide surveillance and data link coverage from the ground up at most major terminals and above 12,500 feet in the en-route airspace. The second procurement, for 60 systems, will complete the system by lowering the en-route coverage to 6,000 feet or to the minimum instrument flight rules altitude if higher.

Status

DOT approved the program to proceed with full production in March 1983. FAA plans to award two sequential contracts—a contract for a total of 137 systems was awarded in October 1984 and a follow-on contract for 60 systems is planned for March 1990. The initial installation of Mode S is scheduled for mid-1988. The program is estimated to cost about $526 million.

Radio Microwave Link (RML)

The existing interfacility communications system is a hybrid of landlines, radio links, and satellite media, and a combination of FAA owned and leased services. The primary FAA-owned medium is radio microwave. RML systems are virtually the only alternative FAA has to a totally leased interfacility communication transmission system. Virtually all existing FAA facilities have interfacility communications requirements. FAA-owned RML systems will play an expanding and changing role from that of primary broadband radar remoting to one of communications trunking. The majority of the FAA-owned systems are over 24 years old and are maintenance-intensive and difficult to supply support. With modern equipment, the FAA transmission systems will offer a viable option to total agency dependence on commercial communications.

As part of the FAA transmission system, the existing RML facilities will serve as a national area transmission medium for voice and data communications. Existing RML equipment, used primarily for radar remoting,

will be replaced with Radio Communications Link equipment that can be used for general purpose interfacility communications. New facilities will be added to tie existing facilities together, forming a complete national radio communications network. FAA plans to replace 750 existing RML facilities and establish an additional 250 new facilities.

Status

DOT approved the program to proceed with full production in March 1984. A contract was awarded in May 1985 to procure 312 units of radio and linking equipment. The estimated cost of this program is about $264 million.

Terminal Radar Program

The airport surveillance radar (ASR) models 4/5/6s were originally procured in 1958. The first system was commissioned in 1960 and the last in the 1964-65 timeframe. Thus, the average age of the hardware and design is currently over 20 years old.

Replacement of all 96 ASR-4/5/6 systems, together with associated air traffic control beacon interrogator equipment, is planned. Present plans call for the direct replacement of 40 ASR-4/5/6 radars with new ASR-9s and the remainder with leapfrog donor ASR-7/8 radars. The 56 donor ASR-7/8 sites will receive ASR-9 radars.

Status

DOT approved the program to proceed with full production in May 1982 and a contract was awarded in September 1983. Delivery of ASR-9 systems is expected to begin in mid-1987. The estimated cost of this program is around $606 million.

Voice Switching and Control System (VSCS)

VSCS provides the man-machine interface and the switching control system for voice communications. The VSCS provides an integrated system for the operation and management of voice communications resources for air traffic control. VSCS is the prime system that supports the availability requirements of operational communications services. It provides the means for reconfiguration of voice communication resources and is a critical item for achieving increased controller productivity along with reduction of leased services costs.

Status

Approval was given by DOT to proceed with the full-scale development and initial production in February 1985, and a prototype request for

proposal was issued in the same month. The estimated cost for this program is about $429 million.

Major System Delays and Changes in Projected Costs

Dollars in millions

Project	Delays in On-Site Implementation (in years) First	Last	Estimated Cost First	Last	Change
HOST	2	1	$455 (9/83)	$406 (4/86)	$−49
AAS	3	8	2,620 (9/83)	3,187 (4/86)	+567
FSAS	4	4	449 (2/81)	480 (4/86)	+31
Mode S	3	0	486 (3/83)	526 (4/86)	+40
CWP	7	2	152 (1/85)	155 (4/86)	+3
Terminal radar	2	1	154 (9/79)[a]	606 (4/86)	+452
MLS	2	0	1,237 (7/81)[b]	1,494 (4/86)	+257
AWOS	5	2	191 (1/86)	203 (4/86)	+12
RML	1	2	264 (3/84)	264 (4/86)	0
LRR	5	4	(c)	485 (4/86)	•
VSCS	4	3	258 (11/82)	429 (4/86)	+171

[a]Estimate is in constant 1978 dollars

[b]Estimate is in constant 1981 dollars

[c]Not yet submitted for DOT approval

Other FAA Acquisition Improvements

Establishment of Policies and Procedures for Independent Cost Estimates

Although FAA's August 1982 acquisition directive provided for an independent cost group to develop agency costing policy and to review cost estimates for major system acquisitions, it was not until May 1984 that FAA issued an order establishing cost estimation policy and procedures and providing for an independent review of project cost estimates. That order—Cost Estimation Policy and Procedures—provided detailed responsibilities, definitions, requirements, descriptions, and methodologies applicable to the cost group's efforts within the agency. The order required that the cost group provide project cost estimates at each of the four key decision points in the major systems acquisition process.

Creation of a NAS Program Management Staff

In June 1985, FAA established the NAS Program Management Staff in its Office of the Associate Administrator for Development and Logistics. The staff is responsible for establishing and operating a NAS Program Management and Control System and for providing direct management support to the NAS Program Director. In its support role, the NAS Program Management Staff serves as executive secretariat to the NAS Program Directorate and coordinates with all FAA organizations and the SEIC. The staff also monitors the progress of individual projects as well as the NAS plan as a whole.

Development of a Baseline Process

FAA's December 1984 internal study noted that FAA did not establish individual NAS plan project milestones early in the project's development to use them as objectives against which they could track project progress, or lack thereof. The study further noted that FAA often replaced the initial milestones it established with new milestones, not retaining the former ones for progress reference. According to the study team, this system of moving baselines rendered the tracking and performance measurement of project progress from originally approved plans and schedules difficult or impossible. The study recommended that FAA establish a baseline of scheduled project milestones early on and retain them as reference points to measure progress throughout the life of individual projects.

During 1985, FAA put in place a baseline process for the NAS plan projects. The process, using the 1985 NAS plan milestones as the baseline rather than original NAS plan milestones, established key milestones and put management review controls into effect for changing project baseline dates.

Hiring of the Systems Engineering and Integration Contractor

FAA's December 1984 internal study also noted that, as a result of the NAS plan, FAA's annual budget for facilities and equipment experienced a five-fold increase, from $260.8 million in fiscal year 1982 to $1.37 billion in fiscal year 1985. The study team pointed out that, while this significant growth in dollar expenditures alone would have put a substantial strain on FAA's ability to properly manage the acquisition process, the complexity and interdependency between the numerous systems and subsystems included in the NAS plan added to that strain.

We and others had expressed concerns in the past over FAA's acquisition management and its effects on cost overruns and schedule slippages. In addition, congressional concerns surfaced shortly after announcement of the NAS plan regarding FAA's ability to successfully implement the NAS plan without significant improvements in its acquisition management and without outside technical assistance. In recognition of the potential problems posed for FAA in implementing the NAS plan, a White House Science Council panel in 1982 recommended that FAA immediately hire a prime contractor to carry out the systems engineering and integration tasks required by the plan.[1]

In January 1984, FAA hired the Systems Engineering and Integration Contractor (SEIC) to support the agency in its implementation of the NAS plan. The SEIC is responsible to the NAS Program Director for management and technical support in all phases of the development and implementation of the NAS plan projects. In addition to the initial evaluation of the NAS plan, the SEIC's responsibilities include

- the assessment of project changes and impacts,
- the development of technical, cost, and schedule estimates,
- the preparation of project specifications,
- the review of technical proposals, and
- the integration of subsystems into operational systems.

Increased Cross-Organizational Involvement

In the past year, FAA has initiated several other actions it believes will improve its management of the acquisition process. These actions, based on recommendations in FAA's December 1984 internal study, include the establishment of program manager "teams" to originate key project documents and the greater involvement of the ultimate FAA users in both

[1]Report of the White House Science Council Panel on the National Airspace System Plan by the FAA, Nov. 1982.

developing technical specifications and statements of work and in project reviews.

According to FAA management officials, FAA now uses a team concept, under the direction of the program manager, to originate and obtain coordination and approval of key project documents. Representatives from organizations having major input to the origination of the project are assigned to the team to collectively draft the project documents and to coordinate them within their respective organizations.

FAA management officials also noted that, under the team concept, the ultimate FAA project users are now involved in preparing technical specifications and statements of work. In addition, project user issues are now a required topic of discussion during formal project reviews.

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